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91164M

911645

Tuhia he (☒) ki te pouaka mēnā kāore koe i tuhi kōrero ki tēnei puka

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NZQA

Mana Tohu Mātauranga o Aotearoa
New Zealand Qualifications Authority

Te Mātai Matū, Kaupae 2, 2023

91164M Te whakaatu māramatanga ki te honohono, ki te hanga, ki ngā āhuatanga me ngā panonitanga o te ngao

Ngā whiwhinga: E rima

Paetae	Kaiaka	Kairangi
Te whakaatu māramatanga ki te honohono, ki te hanga, ki ngā āhuatanga me ngā panonitanga o te ngao.	Te whakaatu māramatanga ki te honohono, ki te hanga, ki ngā āhuatanga me ngā panonitanga o te ngao, kia hōhonu.	Te whakaatu māramatanga ki te honohono, ki te hanga, ki ngā āhuatanga me ngā panonitanga o te ngao, kia tōtōpū.

Tirohia kia kitea ai e ōrite ana te Tau Ākonga ā-Motu (NSN) kei tō puka whakauru ki te tau kei runga i tēnei whārangi.

Me whakamātau koe i ngā tūmahi KATOA kei roto i tēnei pukapuka.

He taka pūmotu, he rauemi tohutoro atu anō hoki kua whakaurua ki te Pukapuka Rauemi L2–CHEMR.

Ki te hiahia wāhi atu anō koe mō ō tuhinga, whakamahia ngā whārangi wātea kei muri o tēnei pukapuka.

Tirohia kia kitea ai e tika ana te raupapatanga o ngā whārangi 2–23 i tēnei pukapuka, ka mutu, kāore tētahi o aua whārangi i te takoto kau.

Kaua e tuhi ki tētahi wāhi e kitea ai te kauruku whakahāngai (AE TUHI KI TĒNEI WĀHI KAUPAE TUHI ki). Ka poroa taua wāhanga ka mākahia ana tēnei pukapuka.

HOATU TĒNEI PUKAPUKA KI TE KAIWHAKAHAERE HEI TE MUTUNGA O TE WHAKAMĀTAUTAU.

TE TŪMAHI TUATAHI

(a) E taea ana te waihā ewaro, te CH_3CH_2OH, te whakamahi hei kora koiora. Ka puta te kora koiora i ngā matū ka hua i ngā rauropi ora. Ko te putanga o te waihā ewaro me te hauhā, me te $CO_2(g)$, i te kūhuka, i te $C_6H_{12}O_6$, e whakaatuhia ana i te whārite kei raro nei.

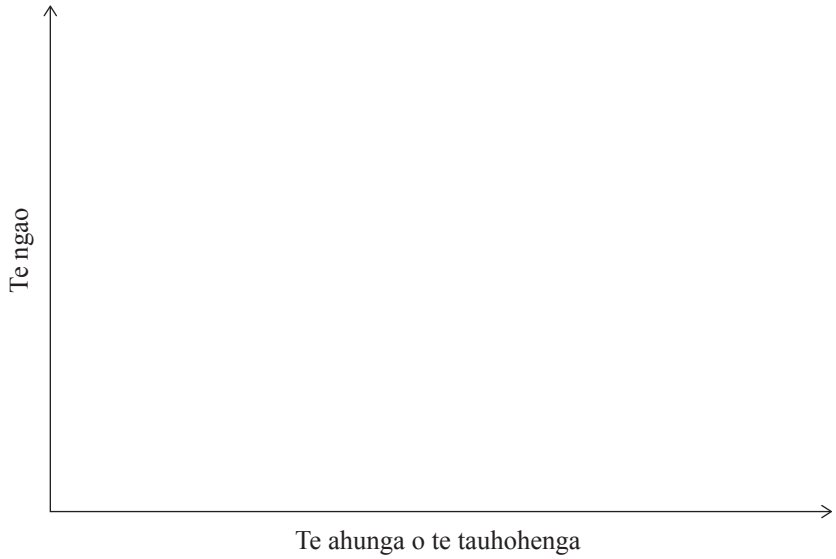
$$C_6H_{12}O_6(aq) \xrightarrow{\text{te īhi}} 2CH_3CH_2OH(aq) + 2CO_2(g) \qquad \Delta_r H = -72 \text{ kJ mol}^{-1}$$

(i) He tukanga pauwera, he tukanga putawera rānei tēnei?

Homai tētahi take i tō whakautu.

(ii) Tuhia tētahi hoahoa ngao kua tapaina mō tēnei tauhohenga, e whakaatu ana i ngā pūmatū hohe, i ngā pūmatū hua me te panonitanga i te ngao pūhana neke *(enthalpy)*, arā, te $\Delta_r H$.

Ko te īhi tētahi whākōkī i tēnei tukanga, ā, kia kaua e whakaurua ki te hoahoa.



(iii) Tātaihia te panonitanga o te ngao ina hua mai te 161 g o te waihā ewaro.

$M(CH_3CH_2OH) = 46.0 \text{ g mol}^{-1}$

QUESTION ONE

(a) Ethanol, CH_3CH_2OH, can be used as a biofuel. Biofuels are formed from materials made by living organisms. The production of ethanol and carbon dioxide, $CO_2(g)$, from glucose, $C_6H_{12}O_6$, is shown in the equation below.

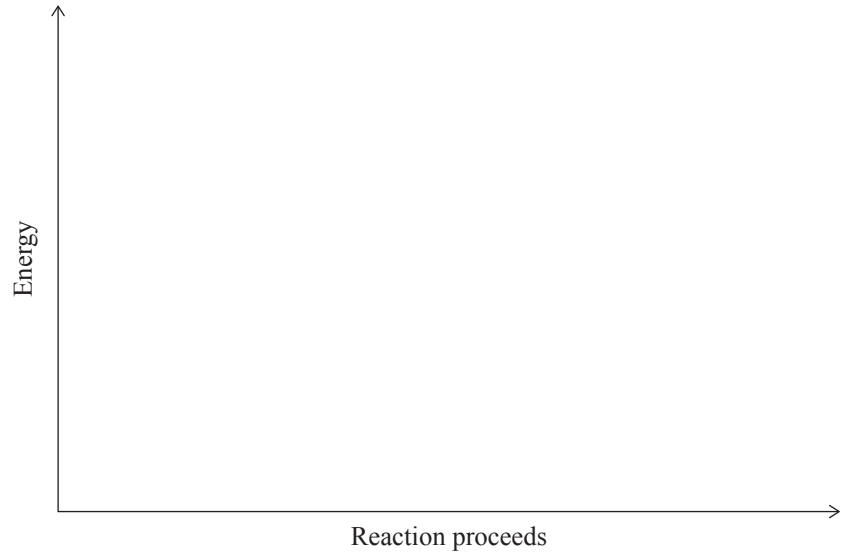
$$C_6H_{12}O_6(aq) \xrightarrow{\text{yeast}} 2CH_3CH_2OH(aq) + 2CO_2(g) \qquad \Delta_r H = -72 \text{ kJ mol}^{-1}$$

(i) Is this process endothermic or exothermic?

Provide a reason with your answer.

(ii) Draw a labelled energy diagram for this reaction, showing reactants, products, and the change in enthalpy, $\Delta_r H$.

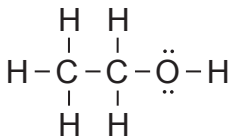
Note that yeast is a catalyst in this process and should not be included in the diagram.



(iii) Calculate the energy change when 161 g of ethanol is formed.

$M(CH_3CH_2OH) = 46.0 \text{ g mol}^{-1}$

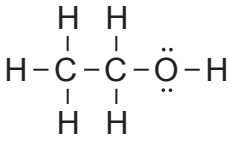
(b) Ko te hoahoa irahiko *(Lewis diagram)* e whakaatuhia ana i raro nei.



Te ngota	Ngā koki honohono huri noa i te ngota
Te waro	109.5°
Te hāora	109.5°

Whakatauritea, whakatauarotia hoki te āhuahanga me ngā koki honohono huri noa i ngā ngota o te waro me te hāora i te waihā ewaro, ka mutu, me whakauru kōrero e pā ana ki te ariā VSEPR.

(b) The Lewis diagram for ethanol is shown below.



Atom	Bond angles around atom
Carbon	109.5°
Oxygen	109.5°

Compare and contrast the shape and bond angles around the carbon and oxygen atoms in ethanol, with reference to VSEPR theory.

(c) Ko te waihā ewaro te waehanga matua i ngā patuero mō te ringa e whai waipiro ana. Ka kitea e tētahi ākonga te tōmiti noa o te patuero mō te ringa i muri i te miringa ki ōna ringa, i rangona ai te mātao o ōna ringa i te mutunga iho. E whakaatuhia ana i raro nei te whārite mō te tōmitinga o te waihā ewaro.

$$CH_3CH_2OH(\ell) \rightarrow CH_3CH_2OH(g)$$

(i) Tuhia he porowhita i te kupu e whakaahua ana i te panonitanga i te ngao pūhana neke *(enthalpy)*, $\Delta_r H$, mō te tōmitinga o te waihā ewaro.

Te $\Delta_r H$ tōrunga **Te $\Delta_r H$ tōraro**

(ii) Whakamāramatia he take e tōmiti noa ai te waihā ewaro, he take hoki e rongo ai ngā ringa o te ākonga i te mātao i te tōmitinga o te waihā ewaro.

I tō tuhinga, me:

- whakaaro ki te whakawhitinga o te ngao i te wā e rere ana te tukanga tōmitinga
- whai kōrero e pā ana ki te hanga me te honohono o roto i te waihā ewaro.

(c) Ethanol is the major component in alcohol-based hand sanitisers. A student noticed that after rubbing the hand sanitiser on their hands, it readily evaporated, leaving their hands feeling cool. The equation for the evaporation of ethanol is shown below.

$$CH_3CH_2OH(\ell) \rightarrow CH_3CH_2OH(g)$$

(i) Circle the word that describes the change in enthalpy $\Delta_r H$, for the evaporation of ethanol.

Positive $\Delta_r H$ **Negative $\Delta_r H$**

(ii) Explain why ethanol readily evaporates, and why the evaporation of ethanol results in the student's hands feeling cool.

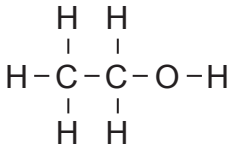
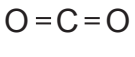
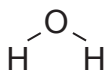
In your answer you should:

- consider the transfer of energy occurring during the evaporation process
- refer to the structure and bonding present in ethanol.

TE TŪMAHI TUARUA

Ka whakamahia te waihā ewaro hei kora mā te whakahohetia ki te haurehu hāora, ki te $O_2(g)$, i tētahi tukanga e kīia nei ko te ngingiha. Ko te ngingihatanga o te haurehu ā-waihā ewaro, o te $CH_3CH_2OH(g)$ e whakaatuhia ana i raro nei.

$$CH_3CH_2OH(g) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(g) \qquad \Delta_r H = -1370 \text{ kJ mol}^{-1}$$

			
CH_3CH_2OH	O_2	CO_2	H_2O

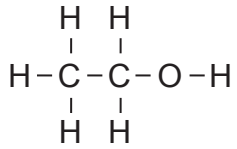
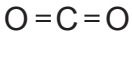
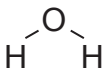
(a) Whakamahia te panonitanga o te ngao pūhana neke ($\Delta_r H$) mō te tauhohenga o runga nei me ngā ngao honohono kua whakarārangitia ki te tūtohi o raro nei hei tātai i te toharite ā-ngao honohono o te honohono O=O.

Te honohono	Te ngao honohono (kJ mol^{-1})
C–C	348
C–H	413
C–O	358
C=O	805
O–H	463

QUESTION TWO

Ethanol is used as a fuel by reacting it with oxygen gas, $O_2(g)$, in a process called combustion. The combustion of gaseous ethanol, $CH_3CH_2OH(g)$ is shown below.

$$CH_3CH_2OH(g) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(g) \qquad \Delta_r H = -1370 \text{ kJ mol}^{-1}$$

 CH_3CH_2OH	 O_2	 CO_2	 H_2O

(a) Use the change in enthalpy ($\Delta_r H$) for the reaction above and the bond energies listed in the table below to calculate the average bond energy of the O=O bond.

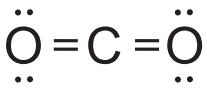
Bond	Bond energy (kJ mol^{-1})
C–C	348
C–H	413
C–O	358
C=O	805
O–H	463

(b) Ko ngā hua o te ngingihatanga o te waihā ewaro, ko te hauhā, te CO_2, me te wai, te H_2O.

CO_2 H_2O

(i) Kei roto i te hauhā ngā ngota o te waro me te hāora. He kaha kē atu te whana tōraro ā-hiko o te hāora i tō te waro.

Tuhia ngā pere e rua (↔), tāpirihia RĀNEI te tohu δ^+ me te tohu δ^- ki te rāpoi ngota o te hauhā e whakaatuhia ana i raro nei hei tohu i ngā whanatīwē *(dipoles)* honohono kei te rāpoi ngota o te hauhā.



(ii) Tuhia he porowhita i te kupu e whakaahua ana i te tōranga o ia rāpoi ngota o raro nei:

Te hauhā (CO_2)	**Whanarua**	**Whanakore**
Te wai (H_2O)	**Whanarua**	**Whanakore**

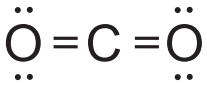
(iii) Whakatauritea, whakatauarotia hoki ngā āhuatanga e whakaaweawe ana i te tōranga o ēnei rāpoi ngota e rua.

(b) The products of the combustion of ethanol are carbon dioxide, CO_2, and water, H_2O.

CO_2 H_2O

(i) Carbon dioxide contains carbon and oxygen atoms. Oxygen is more electronegative than carbon.

Draw two arrows (↔) OR add δ^+ and δ^- symbols onto the carbon dioxide molecule shown below to represent the bond dipoles present in the carbon dioxide molecule.



(ii) Circle the word that describes the polarity of each molecule below:

Carbon dioxide (CO_2)	**Polar**	**Non-polar**
Water (H_2O)	**Polar**	**Non-polar**

(iii) Compare and contrast the factors that influence the polarity of these two molecules.

(c) Ka hua pea i te ngingihatanga o ngā kora ngā huataha e tāoke ana, pēnei i te haukino, arā, te CO. Ka taea te whakamahi te pūtahuri ā-whākōkī *(catalytic converter)* hei huri i ēnei pūhui kia māmā ake te kino o ngā matū. He nui ngā wā kei roto i ngā pūtahuri ā-whākōkī te pūmotu konukawata mārō *(palladium)*, te Pd.

(i) Whakaotihia te tūtohi o raro nei mō tēnā, mō tēnā o ngā matū e totoka ana.

Te matū	**Te momo totoka**	**Te momo korakora**	**Ngā tōpana pipiri**
Te haukino, CO(*s*)			
Te konukawata mārō, Pd(*s*)			

(ii) Ka whakaraerae ana te konukawata mārō *(palladium)* ki ngā hau e wera ake ana i te 300 °C, ka totoka tonu.

Whakamahia ō mōhiotanga ki te hanga me te honohono kia whakamāramatia te pae rewa tiketike o te konukawata mārō *(palladium)*.

(c) The combustion of fuels can result in toxic by-products, such as carbon monoxide, CO.
A catalytic converter can be used to convert these compounds to less harmful substances.
Catalytic converters often contain the element palladium, Pd.

(i) Complete the table below for each of these substances in their solid states.

Substance	**Type of solid**	**Type of particle**	**Attractive forces**
Carbon monoxide, CO(*s*)			
Palladium, Pd(*s*)			

(ii) When exposed to exhaust gases greater than 300 °C, palladium remains in its solid state.

Use your knowledge of structure and bonding to explain the high melting point of palladium.

TE TŪMAHI TUATORU

(a) Tuhia te hoahoa irahiko *(Lewis diagram)* mō tēnā, mō tēnā o ngā rāpoi ngota e whai ake nei, ā, homai ngā āhuahanga.

Te rāpoi ngota	PH_3	BCl_3	$COBr_2$
Te hoahoa irahiko			
Te ingoa o te āhuahanga			

(b) Ko te putanga o te pūkanerua ā-waro *(carbonic dibromide)*, o te $COBr_2(\ell)$ e whakaatuhia ana i te whārite o raro nei.

$$2C(s) + O_2(g) + 2Br_2(\ell) \rightarrow 2COBr_2(\ell) \qquad \Delta_r H = -145 \text{ kJ mol}^{-1}$$

(i) Tātaihia te papatipu o te pūkanerua ā-waro *(carbonic dibromide)* ka puta ina tukuna te ngao o te 1150 kJ.

$M(COBr_2) = 187.8 \text{ g mol}^{-1}$

(ii) E pīrangi ana tētahi kaimātai matū kia puritia te papatipu o te pūkanerua ā-waro *(carbonic dibromide)* ki tētahi puoto 1 L.

Mehemea e 2.52 g te papatipu o te 1 mL o te wē pūkanerua ā-waro, ka puritia rānei ki roto i te puoto?

QUESTION THREE

(a) Draw the Lewis diagram (electron dot diagram) for each of the following molecules, and give their shapes.

Molecule	PH_3	BCl_3	$COBr_2$
Lewis diagram			
Name of shape			

(b) The formation of carbonic dibromide, $COBr_2(\ell)$ is shown in the equation below.

$$2C(s) + O_2(g) + 2Br_2(\ell) \rightarrow 2COBr_2(\ell) \qquad \Delta_r H = -145 \text{ kJ mol}^{-1}$$

(i) Calculate the mass of carbonic dibromide formed when 1150 kJ of energy is released.

$M(COBr_2) = 187.8 \text{ g mol}^{-1}$

(ii) A chemist wishes to store this mass of carbonic dibromide in a 1 L flask.

If 1 mL of carbonic dibromide liquid has a mass of 2.52 g, will they be able to contain it within the flask?

(c) Kāore te hiko e kawea e te pūkanerua ā-waro *(carbonic dibromide)*, e te $COBr_2$, ahakoa e totoka ana rānei, e wē ana rānei. Heoi anō, tērā tētahi atu pūhui kei roto rā te pūkane, arā, te pūkane konukōhatu *(lithium bromide)*, te LiBr, e kawe ana i te hiko ina rewa, engari kaua i te wā e totoka ana .

Whakawhānuihia ngā kōrero mō te kawenga ā-hiko o te pūkanerua ā-waro *(carbonic dibromide)* me te pūkane konukōhatu *(lithium bromide)*, me te whai kōrero e pā ana ki te hanga me te honohono o roto i ia pūhui.

(c) Carbonic dibromide, $COBr_2$, does not conduct electricity in either the solid or liquid state. However, another bromine-containing compound, lithium bromide, LiBr, conducts electricity when molten, but not when solid.

Elaborate on the electrical conductivity of both carbonic dibromide and lithium bromide, with reference to the structure and bonding in each compound.

(d) Mā te whai kōrero e pā ana ki ngā tōpana pipiri i waenga i ngā korakora, whakamāramatia he take e kore ai te pūkane konukōhatu *(lithium bromide)*, te LiBr(*s*), e memeha i ngā tāmeha whanakore *(non-polar)* pēnei i te hauwai penehīni *(cyclohexane)*, i te $C_6H_{12}(\ell)$, engari ka memeha pea i ngā tāmeha pēnei i te wai, i te $H_2O(\ell)$.

(d) By referring to the attractive forces between particles, explain why lithium bromide, LiBr(s), is unable to dissolve in non-polar solvents such as cyclohexane, $C_6H_{12}(\ell)$, but can dissolve in polar solvents such as water, $H_2O(\ell)$.

He whārangi anō ki te hiahiatia.
Tuhia te tau tūmahi mēnā e hāngai ana.

TE TAU TŪMAHI

Extra space if required.
Write the question number(s) if applicable.

QUESTION NUMBER	

He whārangi anō ki te hiahiatia.
Tuhia te tau tūmahi mēnā e hāngai ana.

TE TAU TŪMAHI

Extra space if required.
Write the question number(s) if applicable.

QUESTION NUMBER	

English translation of the wording on the front cover

Level 2 Chemistry 2023

91164M Demonstrate understanding of bonding, structure, properties and energy changes

Credits: Five

91164M

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of bonding, structure, properties and energy changes.	Demonstrate in-depth understanding of bonding, structure, properties and energy changes.	Demonstrate comprehensive understanding of bonding, structure, properties and energy changes.

Check that the National Student Number (NSN) on your admission slip is the same as the number at the top of this page.

You should attempt ALL the questions in this booklet.

A periodic table and other reference material are provided in the Resource Booklet L2–CHEMR.

If you need more room for any answer, use the extra space provided at the back of this booklet.

Check that this booklet has pages 2–23 in the correct order and that none of these pages is blank.

Do not write in any cross-hatched area (DO NOT WRITE IN THIS AREA DO NOT WRITE). This area will be cut off when the booklet is marked.

YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.